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Using a Survey to Estimate Health Expectancy and Quality-Adjusted Life Expectancy to Assess Inequalities in Health and Quality of Life

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ABSTRACT

Background: There has been a policy debate in the United Kingdom about moving beyond traditional measures of life expectancy and economic output to developing more meaningful ways of measuring national well-being. **Objective:** To test whether quality adjusted life expectancy (QALE) was a useful indicator of health inequalities. **Methods:** EuroQol five-dimensional questionnaire data from a well-being survey was combined with actuarial life expectancy (LE) data to estimate healthy LE (HLE), that is, years of life lived in good health, and QALE, that is, quality-adjusted life-years (QALYs) lived for Wirral, a borough in the north west of England. **Results:** The gap between Wirral and the most deprived areas was 4.45 years for LE, 5.34 for QALE, and 7.55 for HLE. The gap in QALE was 20% greater than the gap in LE, while the gap in HLE was 70% greater. **Conclusions:** The fact that the QALE gap value lies between the HLE value and the LE value suggests that QALE is a more sensitive indicator than HLE, as in this study QALE is derived from 243 possible EuroQol five-dimensional questionnaire profiles whereas HLE is based only on whether or not an individual rates his or her health as good, a binary variable. This study discusses how QALE could be a useful indicator for measuring health inequalities in future, especially as cost utility and QALYs are seen as the gold standard used by the National Institute for Health and Clinical Excellence in the United Kingdom to measure outcomes for health interventions in England, and discusses how a monetary valuation of QALYs could be used to put a societal cost on health inequalities.

Keywords: EQ-5D, health inequalities, population surveys, QALYs.

Introduction

In the United Kingdom, there has been a recent policy debate about regarding well-being as an economic good, measured alongside established measures of income, such as gross domestic product, and health, such as life expectancy (LE) [1]. This change in focus chimes with Organisation for Economic Co-operation and Development's Istanbul Declaration [2] on improving well-being and considers the Easterlin paradox first described in 1974 [3]—that increasing income does not always increase happiness, and hedonic treadmill theory, that adverse life events do not change an individual's level of happiness as much as expected [4]. The UK Office for National Statistics (ONS) has formulated well-being measures across 10 domains: the economy, individual well-being, our relationships; where we live, health, natural environment, personal finance, what we do, governance, and education and skills [5].

The United Kingdom had increasing levels of income inequalities since the 1970s, with inequalities in health outcomes remaining despite targeted investment [6]. The gap in health expectancy or healthy LE (HLE) between areas is typically wider than the gap in LE, indicating that health inequalities are greater when morbidity and mortality are combined. In the EU-27 countries, the largest LE gap between countries for males is 12.3 years (between Iceland and Lithuania) whereas the largest HLE gap is 50% greater at 18.4 years (between Sweden and Slovakia). For females, the largest LE gap is 7.6 years whereas the largest HLE gap is 18.3 years (data for 2009 [7]). A study comparing quality-adjusted LE (QALE) across countries found some interesting patterns, with women in two countries (Spain and The Netherlands) having a smaller QALE gap than the LE gap, meaning that Spanish women live longer with more health problems than Dutch women [8].

The ONS has previously measured disability-free LE as well as HLE at birth and at age 65 years, calculated by combining actuarial cohort LE data with survey data. Although the EuroQol five-dimensional (EQ-5D) questionnaire is used in population health surveys such as the Health Survey for England, it has not been routinely used to assess quality-adjusted life-years (QALYs) experienced across a population. There is a disparity between the UK gold standard in measuring health outcomes (the EQ-5D questionnaire and QALYs recommended by the National Institute for Health and Clinical Excellence) and what is seen as the gold standard in measuring health status across the population (measures such as the HLE recommended by the ONS). Internationally, disability-adjusted life-years are used for the World Health Organization's Global Burden of Disease project, which was recently updated [9].

The EQ-5D 3-level questionnaire is a self-reported health-related quality of life tool that consists of five dimensions (mobility, self-care, usual activities, pain/discomfort, and anxiety/depression) each of which can take one of three levels of

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severity (no problems/some or moderate problems/extreme problems). The EQ-5D questionnaire profiles are matched to UK utility scores, giving the desirability of a particular health state, measured between −0.594 (worst health state) and 1 (perfect health). In a randomized controlled trial, change in utility as a result of a health intervention is measured in the same person at baseline and at set time intervals, so that any change can be attributed to the intervention. This change in utility is used to calculate QALYs experienced. The EQ-5D questionnaire being self-reported has an element of subjectivity where individuals may have similar health status but responses indicate different levels of health problems. In a randomized controlled trial, individual improvement in the EQ-5D questionnaire is used to calculate the QALYs gained, and so this accounts for some of the subjectivity, an improvement is always an improvement. But in a population-level study such as this, each individual is completing the EQ-5D questionnaire once; however, with a large sample size (1522 people in this study), some of these subjective differences would even out across the population. This element of subjectivity is also true for HLE, which is widely used as a measure of health status. It has been claimed that the EQ-5D questionnaire is not sensitive in measuring health problems such as fatigue, sensory impairment, or mental health problems, and if so then the impact of these conditions would be underrepresented in QALE derived from EQ-5D questionnaire survey data.

The aim of this study was to show that because QALE is based on the EQ-5D questionnaire profile, which has 243 possible health states, QALE will be more robust as an indicator of population health than LE or HLE, which are both essentially based on binary variables, that is, whether after a period of time an individual is still alive, and if he or she is, whether he or she rates his or her health as good.

Methods

LE, HLE, and QALE were calculated for Wirral, a borough in the northwest of England, with an estimated ONS population of 309,000 people in 2009. This area was chosen because Wirral has extremes of affluence and poverty, with the east side containing some of the most deprived areas in England and the west side being an affluent retirement destination. Data were combined from a well-being survey [10] that was commissioned for the northwest of England (N = 1522 for Wirral), and carried out in 2009, and mortality and population data for 2005-2007 (3 years pooled), the most recent data available when the results were analyzed. The methods for collecting the survey are described in more detail elsewhere [11]. Survey data were weighted by age, gender, and deprivation, and so the scores should represent a true average. The weighted EQ-5D questionnaire index scores and health status scores were combined for males and females and grouped into six age bands, 16 to 17, 18 to 24, 25 to 39, 40 to 54, 55 to 64, and 65 years and older. These utility scores used the UK EQ-5D questionnaire value set produced by EuroQol using a representative sample (3359 people) of the UK population using the time trade-off method [12]. Because the well-being survey was carried out only on individuals aged 16 years and older, a maximum utility score of 1 and a probability of reporting oneself as being healthy of 1 was assumed for those younger than 16 years.

Cohort LE was calculated by using the Chiang II method [13] used by the UK ONS. The utility and self-reported health data were combined with the LE data by using the method outlined by Sullivan in 1971 [14]. This is where QALE is calculated as follows:

$$\mathrm{QALE} = \frac{\sum_{a}^{z}(U_a \cdot P_a)}{\Sigma \mathrm{P}} \cdot \mathrm{LE}$$

where U_a is average utility in age group a, P_a is the population surviving in age group a, z is the maximum age group, and LE is total cohort life expectancy (years).

To understand inequalities in health and quality of life, the analysis was carried out for the whole of Wirral, as well as for the areas of Wirral that fell into the 20% most deprived and 20% least deprived lower layer super output areas (a small area geography used by the ONS, where each contains on average 1500 people) nationally based on the Index of Multiple Deprivation 2007, which is a widely used UK deprivation measure [15]. Of the Wirral population at the time, 32% fell into the most deprived quintile and 10% into the least deprived quintile.

Results

The differences in utility and LE were analyzed for Wirral as a whole and for the most and least deprived quintiles. The characteristics of respondents from each group are shown in Table 1. The least deprived areas have a greater proportion of males answering the survey, are older on average, and have a greater proportion of people in employment. The groups were similar for average mental well-being score as measured by using

Table 1 – Comparative statistics for the most and least deprived areas and the whole of Wirral.

	Most deprived	Least deprived	Whole of Wirral
N	687	75	1522
Average age (y)	49.6	57.9	52.4
Gender, male (%)	36.3	48	38.9
Average Short Warwick-Edinburgh Mental Wellbeing Scale score	27.75	28.09	28.00
Work status (%)			
Not recorded	0.9	1.3	1.2
Full-time education	2.3	1.3	1.6
Not working for domestic reasons	9.8	0.0	6.8
Other	1.7	0.0	1.3
Out of work, registered unemployed but not actively seeking work	2.6	1.3	2.2
Out of work, registered unemployed and actively seeking work	8.3	4.0	6.8
Paid work: full-time	23.6	41.3	25.8
Paid work: part-time	7.6	10.7	9.2
Permanently sick or disabled	10.9	0.0	7.5
Refused	0.4	0.0	0.5
Retired	30.4	36.0	35.2
Self-employed	1.5	4.0	2.0

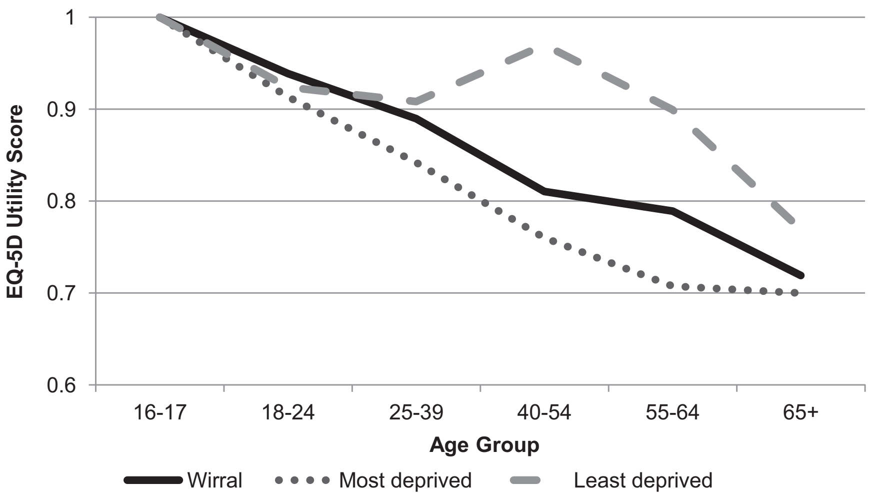

Fig. 1 – Average EQ-5D questionnaire index utility score by age group, whole of Wirral, Wirral most deprived, and Wirral least deprived. EQ-5D, EuroQol five-dimensional.

the Short Warwick Edinburgh Mental Wellbeing Scale. The sample size in the most deprived areas is much greater, because people in the most deprived quintile make up a greater proportion of the population in Wirral than do those in the least deprived, and a booster sample in the most deprived areas was commissioned.

With an independent samples *t* test, there was a significant difference in EQ-5D-questionnaire– derived utility scores between deprivation quintile 5 (most deprived) (mean ± SD = 0.749 ± 0.343) and deprivation quintiles 1 to 4 (the rest of Wirral) (mean ± SD = 0.809 ± 0.286; $t(1522) = -3.710$; $P < 0.001$). This result means that the most deprived areas experienced significantly lower utility on average than did the rest of Wirral.

Weighted utility scores were lower for the most deprived areas than for Wirral and for the least deprived areas for all age groups except 18 to 24 years. The differences were most pronounced in the 40 to 54 and 55 to 64 year age groups, with a 25% gap between most and least deprived (Fig. 1). The utility scores were from a population sample, not a cohort, and so the smaller difference in older age groups could be due to a healthy survivor effect where individuals with the worst health have died at a younger age.

In terms of LE, the gap between the least and most deprived areas in Wirral was 8.1 years, while the QALE gap was greater at 12.7 years, and the gap in HLE was the greatest at 14.7 years (see Table 2 and Fig. 2). Between Wirral and the most deprived areas, the gap was 4.45 years for LE, 5.34 for QALE, and 7.55 for HLE. The gap in QALE was 20% greater than the gap in LE, while the gap in HLE was 70% greater.

Discussion

For Wirral, years lived in good health were 73.7 on average for 2005 to 2007, an increase of 6.1 years since the Census in 2001 when the HLE was 68.6 years, although it may be that there are methodological issues with the survey used, such as it under-representing people who live in nursing homes or hospitals who

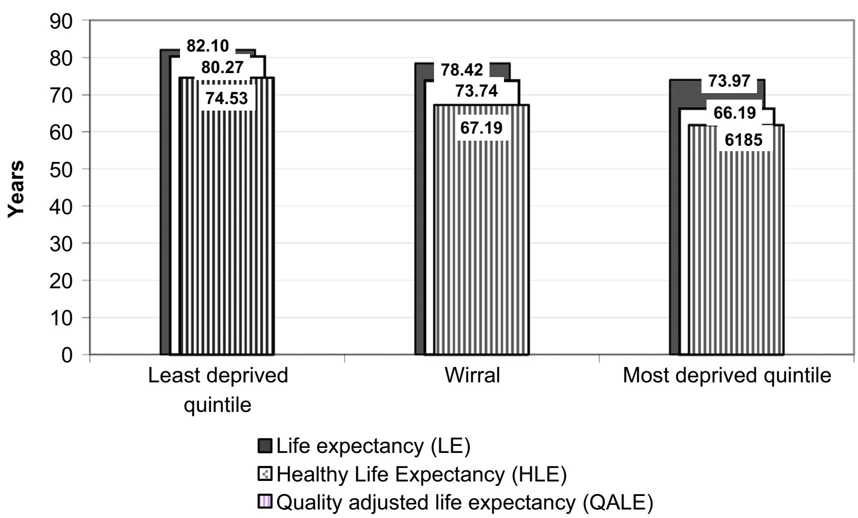

Fig. 2 – Life expectancy, healthy life expectancy and quality adjusted life expectancy in Wirral, based on mortality and population data for 2005-07.

Table 2 – Life expectancy, healthy life expectancy, and quality-adjusted life expectancy in Wirral, most and least deprived areas, based on mortality and population data for 2005–2007.

	Least deprived quintile	Wirral	Most deprived quintile	Gap—Least vs. most deprived quintile
Life expectancy (y)	82.1	78.4	74.0	8.1
Health expectancy (y)	80.3	73.7	66.2	14.1
Years lived in poor health	1.8	4.7	7.8	−5.9
Quality-adjusted life expectancy (y)	74.5	67.2	61.8	12.7

are likely to have poorer health and lower utility scores. The sample size of the survey was quite large (1522 across Wirral), and was weighted for age, gender, and deprivation, but there were two relatively affluent areas of Wirral, Heswall and Royden, underrepresented in the survey data. Also, the survey was carried out only on individuals aged 16 years and older, and so we have assumed a maximum utility score of 1 for ages under 16 years, which was the average for 16- to 17-year-olds in the survey; however, it is likely that very young children suffer from more illnesses than do 16- 17-year-olds, meaning lower utility.

This study shows that depending on which measure is used, health inequalities can be shown to be much wider than the gap in LE alone. It may not be a surprise that the QALE gap is wider than the LE gap, as people who are healthy will generally live longer, but being able to quantify the gap over time will give an idea of how the gap has changed, and there are examples (such as comparing women in Spain and The Netherlands) where the LE gap is wider than the QALE gap, which is useful for stimulating discussion around trade-offs between health and longevity.

This study has shown how individuals living just a few kilometers away from each other in Wirral are experiencing health and illness differently; and Wirral has been said to be almost a microcosm of England in terms of having wide health inequalities. The fact that the QALE gap value lies between the LE gap value and the HLE gap value can be regarded as good evidence that it may be closer to the true picture of health expectancy. Whereas HLE is based on a binary variable, the EQ-5D 3-level questionnaire has 243 different health states.

Because EQ-5D-questionnaire–derived utility scores can be less than zero, this could pose a mathematical problem in using QALE as a population health indicator, because people with utility scores less than zero would have negative QALE, and would in effect have their LE deducted from the population LE. We used average utility scores in each age group, but scores below zero will have contributed to these averages. Some other studies have used adjusted utility values that were floored at zero [16]. This ability of EQ-5D questionnaire indices to be less than zero may be one of the reasons it is not routinely used to measure health-adjusted LE across a population, because this may be ethically or methodologically controversial.

A study by Burström et al. [17] put a monetary value on the QALY gains that occurred over a period of time in Sweden, using a value of $100,000 per QALY. Monetary values are not typically attributed to health inequalities in this way in UK policy literature. The quoted National Institute for Health and Clinical Excellence threshold for paying for new technologies is an incremental cost-effectiveness ratio of £30,000 per QALY gained. From the QALE data, it can be calculated how many QALYs would be needed to raise the QALE in the most deprived areas to that of the whole of Wirral; this is 2053.9 QALYs per year. It can therefore be said that at this threshold of £30,000 per QALY, the QALE gap in Wirral is worth £61.6 million per year, or £620 per person in the most deprived quintile. This lost potential for quality and quantity of life could be considered as a premium that the society pays for allowing such social inequities that manifest themselves in health behaviors and outcomes from before birth. This is only taking into account the threshold for investment to reduce health inequalities alone, as other forms of spending, such as on parks, policing, or social care, do not have a similar decision rule, but would be closely bound to health inequalities and well-being.

Limitations of this analysis are that the well-being survey was for a slightly different time period than the mortality and population data were for, 2009 against 2005–2007. The data we used were for all persons combined; the reason for not splitting by gender was because otherwise the numbers for individual deprivation quintiles and age groups would be too low to produce significant results. If males and females were analyzed separately, then males would have a lower LE and a wider gap between the most and least deprived, as the Slope Index of Inequality data for Wirral indicates [18]. To calculate QALYs experienced, we used the population in each age group and the average utility. We did not attempt to turn the utility scores into a continuous curve, and so this may affect the QALE calculation, in particular in the 65+ years age group, which is open-ended.

In conclusion, this article has outlined a method of combining health-related quality of life data (in this case using the EQ-5D questionnaire) with LE data to illuminate the socioeconomic gradient in QALE. We have shown that in Wirral, average utility in the most deprived areas was significantly lower than in the rest of Wirral, and the gap in QALE was greater than the LE gap, and less than the HLE gap. This indicator of health inequalities could be used in future for testing the impact of health interventions on QALYs experienced across a population.

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